

FIG. 1 (PRIOR ART)

250

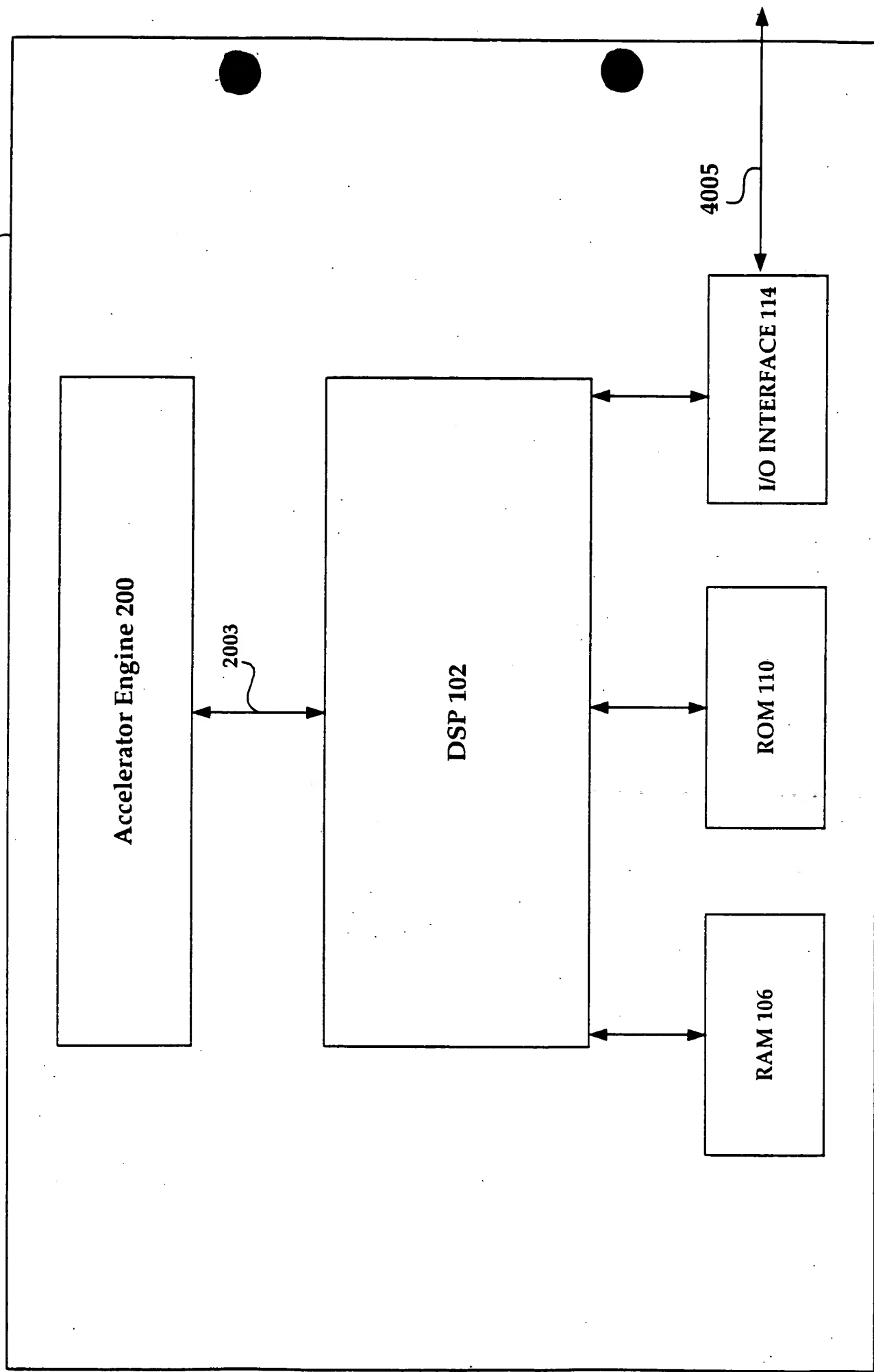


FIG. 2

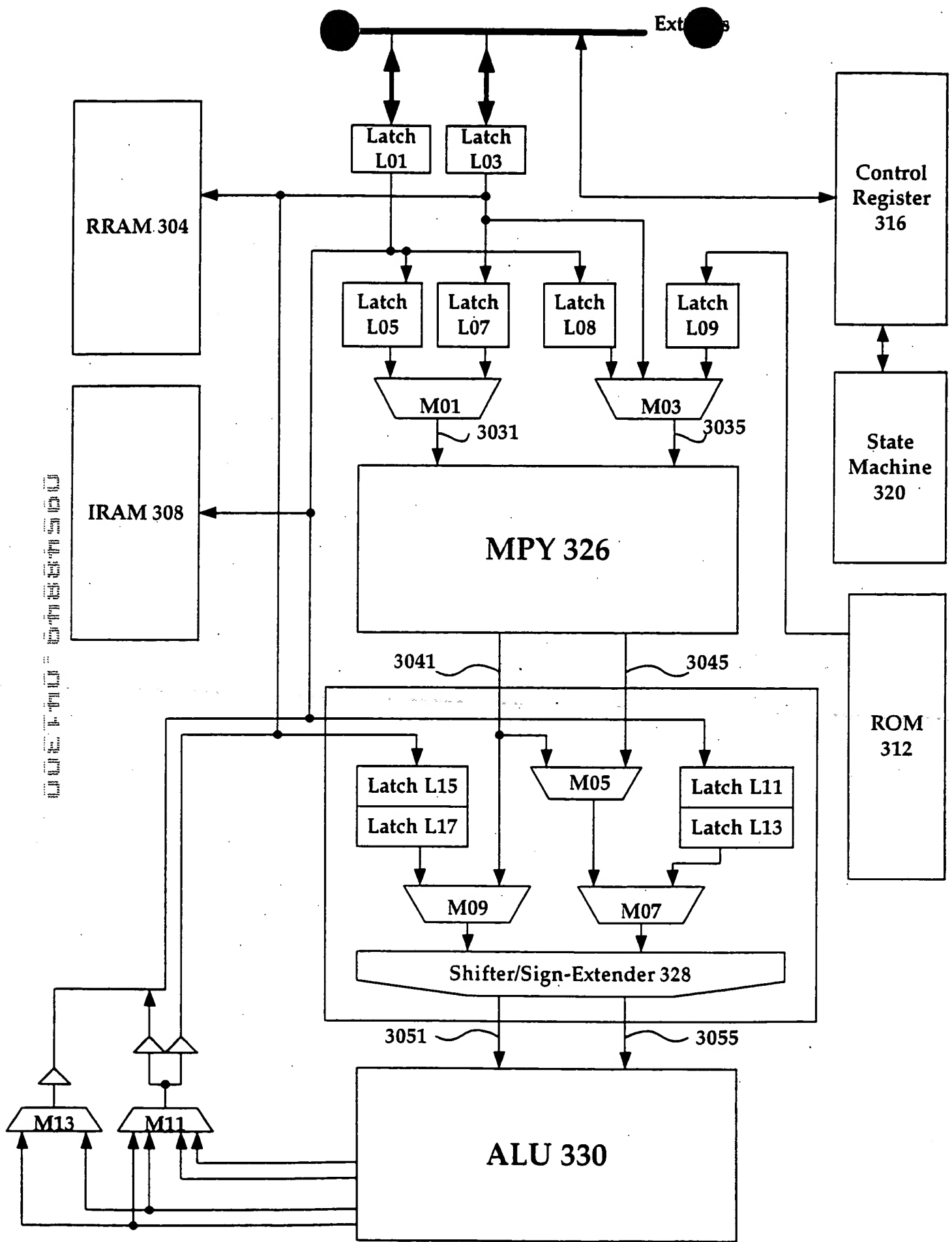


FIG. 3

Cycle	MPY 326	ALU A	ALU B	RRAM 304	IRAM 308	ROM 312
1				read $b_r$	read $b_i$	read $c_r$
2						read $c_i$
3	$b_r * c_r$					read $c_i$
4	$b_i * c_i$					read $c_r$
5	$b_r * c_i$					
6	$b_i * c_r$	$A = b_r * c_r$				
7		$A_0 = A - (b_i * c_i)$				
8			$B = b_r * c_i$			
9			$B_0 = B + (b_i * c_r)$			
10				write $b_r$	write $b_i$	
11						
12						

FIG. 4A

Cycle	MPY 326	ALU A	ALU B	RRAM 304	IRAM 308	ROM 312
1	1	0	1	1	1	1
2	1	1	0	1	1	1
3	1	1	0	0	0	1
4	1	0	1	0	0	1

FIG. 4B

Cycle	MPY 326	ALU A	ALU B	RRAM 304	IRAM 308	ROM 312
1				read $b_r$		read $c_r$
2					read $b_i$	read $c_i$
3	$b_r * c_r$					read $c_i$
4	$b_i * c_i$			read $a_r$		read $c_r$
5	$b_r * c_i$				read $a_i$	
6	$b_i * c_r$	$A = b_r * c_r$				
7		$A = A - b_i * c_i$				
8		$A_1 = a_r - A$	$B = b_r * c_i$			
9		$A_0 = a_r + A$	$B = B + (b_i * c_i)$			
10			$B_1 = a_i - B$	write $A_1$		
11			$B_0 = a_i + B$	write $A_0$	write $B_1$	
12					write $B_0$	

FIG. 5A

Cycle	MPY 326	ALU A	ALU B	RRAM 304	IRAM 308	ROM 312
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1

FIG. 5B

```

Group = 1;
Block = FFT Length / 2;          /* 64 or 32 */
R2P = Log (FFT Length) ;         /* 7 or 6 */
for(i=0;i<R2P;i++)               /* radix 2 pass counter */
{
    Aiptr=0;                      /* initialize A imaginary pointer */
    Arptr=0;                      /* initialize A real pointer */
    Biptr=Block;                  /* initialize B imaginary pointer */
    Brptr=Block;                  /* initialize B real pointer */
    for(j=0;j<Group;j++)
    {
        for(k=0;k<Block;k++)
        {
            /* perform butterfly here */

            ar = *Arptr;           /* fetch data */
            ai = *Aiptr;
            br = *Brptr;
            bi = *Biptr;

            rtemp = br * cr - bi * ci; /* perform complex multiply */
            itemp = br * ci + bi * cr;

            *Arptr++ = ar - rtemp;    /* update and write back data */
            *Aiptr++ = ai - itemp;
            *Brptr++ = ar + rtemp;
            *Biptr++ = ai + itemp;
        }

        Aiptr+=block;              /* update addresses to next group */
        Arptr+=Block;
        Biptr+=Block;
        Brptr+=Block;
    }

    Block>>=1;                    /* update block size for next radix 2 pass */
    Group<<=1;                     /* update group size for next radix 2 pass */
}

```

**FIG. 5C**



Cycle	MPY 326	ALU 330	RRAM 304	IRAM 308
1			read $b_2$	read $x_{n-2}$
2			read $b_1$	read $x_{n-1}$
3	$b_2 * x_{n-2}$		read $b_0$	read $x_n$
4	$b_1 * x_{n-1}$		read $a_2$	read $y_{n-2}$
5	$b_0 * x_n$		read $a_1$	
6	$a_2 * y_{n-2}$	$A = b_2 * x_{n-2}$		
7	$a_1 * y_{n-1}$	$A = A + (b_1 * x_{n-1})$		
8		$A = A + (b_0 * x_n)$		
9		$A = A + (a_2 * y_{n-2})$		
10		$A_0 = (A + (a_1 * y_{n-1})) * 2$		
11				
12				write $y_n (A_0)$

FIG. 6A

Cycle	MPY 326	ALU 330	RRAM 304	IRAM 308
1	1	1	1	1
2	0	1	1	1
3	1	1	1	1
4	1	1	1	1
5	1	0	1	0
6	1	1	0	1

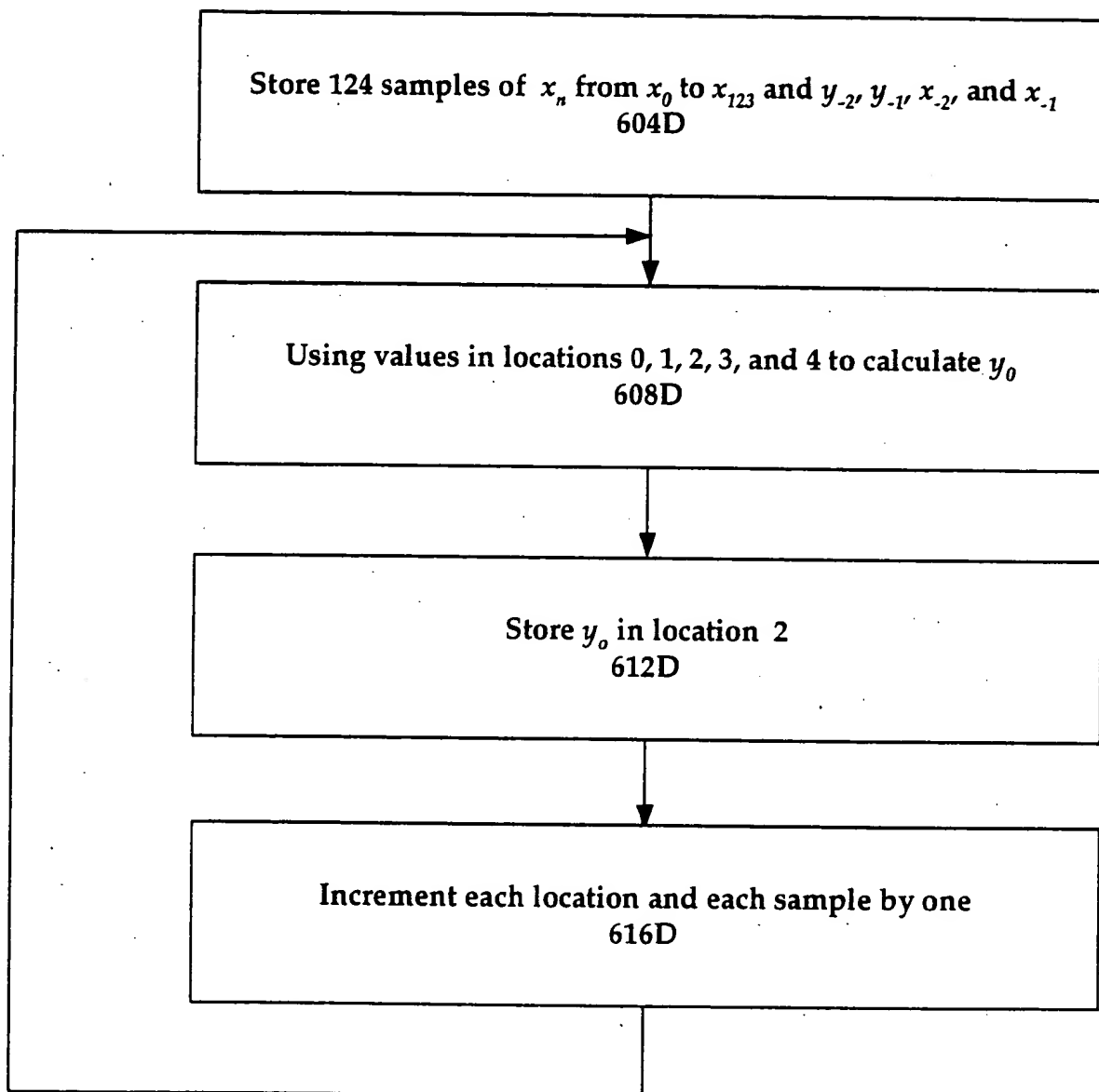
**FIG. 6B**

```

graph TD
    Start(( )) --> 604[Receive x data in block of 124 samples  
604]
    604 --> 608[Store data in memory  
608]
    608 --> 612[Calculate  $y_n$   
612]
    612 --> 616{All data received?  
616}
    616 -- N --> 604
    616 -- Y --> 620[Done  
620]

```

**FIG. 6C**

[illegible]

**FIG. 6D**

Address	Initial Data	Data n=0	Data n=1	Data n=2	Data n=123
0	$y_{-2}$	$y_{-2}$	$y_{-2}$	$y_{-2}$	$y_{-2}$
1	$y_{-1}$	$y_{-1}$	$y_{-1}$	$y_{-1}$	$y_{-1}$
2	$x_{-2}$	$y_0$	$y_0$	$y_0$	$y_0$
3	$x_{-1}$	$x_{-1}$	$y_1$	$y_1$	$y_1$
4	$x_0$	$x_0$	$x_0$	$y_2$	$y_2$
5	$x_1$	$x_1$	$x_1$	$x_1$	$y_3$
.	.	.	$x_2$	$x_2$	$y_4$
.	.	.	.	$x_3$	.
.	.	.	.	.	.
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.	.	.	.	.	.
124	$x_{120}$	$x_{120}$	$x_{120}$	$x_{120}$	$y_{122}$
125	$x_{121}$	$x_{121}$	$x_{121}$	$x_{121}$	$y_{123}$
126	$x_{122}$	$x_{122}$	$x_{122}$	$x_{122}$	$x_{122}$
127	$x_{123}$	$x_{123}$	$x_{123}$	$x_{123}$	$x_{123}$

FIG. 6E

Cycle	MPY 326	ALU 330	RRAM 304	IRAM 308
1			read $b_2$	read $x_{n-2}$
2			read $b_1$	read $x_{n-1}$
3	$b_2 * x_{n-2}$		read $b_0$	read $x_n$
4	$b_1 * x_{n-1}$		read $a_2$	read $yl_{n-2}$
5	$b_0 * x_n$			read $y_{n-2}$
6	$a_2 * yl_{n-2}$	$A = b_2 * x_{n-2}$	read $a_1$	
7	$a_2 * y_{n-2}$	$A = A + (b_1 * x_{n-1})$		
8	$a_1 * yl_{n-1}$	$A = A + (b_0 * x_n)$		
9	$a_1 * y_{n-1}$	$A = A + (a_2 * yl_{n-2})$		
10		$A = A + (a_2 * y_{n-2})$		
11		$A = A + (a_1 * yl_{n-1})$		
12		$A_0 = A + (a_1 * y_{n-1})$		
13				
14				
15				
16				
17				write $yl_n (B_0)$
16				write $y_n (A_0)$

FIG. 7A



Address	Initial Data	Data n=0	Data n=1	Data n=2	Data n=121
0	yh <sub>2</sub>	yh <sub>2</sub>	yh <sub>2</sub>	yh <sub>2</sub>	yh <sub>2</sub>
1	yh <sub>1</sub>	yh <sub>1</sub>	yh <sub>1</sub>	yh <sub>1</sub>	yh <sub>1</sub>
2	yl <sub>2</sub>	yh <sub>0</sub>	yh <sub>0</sub>	yh <sub>0</sub>	yh <sub>0</sub>
3	yl <sub>1</sub>	yl <sub>1</sub>	yl <sub>1</sub>	yl <sub>1</sub>	yl <sub>1</sub>
4	x <sub>2</sub>	yl <sub>0</sub>	yl <sub>0</sub>	yl <sub>0</sub>	yl <sub>0</sub>
5	x <sub>1</sub>	x <sub>1</sub>	yl <sub>1</sub>	yl <sub>1</sub>	yl <sub>1</sub>
.	x <sub>0</sub>	x <sub>0</sub>	x <sub>0</sub>	yl <sub>2</sub>	yl <sub>2</sub>
.	.	x <sub>1</sub>	x <sub>1</sub>	x <sub>1</sub>	yl <sub>3</sub>
.	.	.	x <sub>2</sub>	x <sub>2</sub>	yl <sub>4</sub>
.	.	.	.	x <sub>3</sub>	yl <sub>5</sub>
.	.	.	.	.	.
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.	.	.	.	.	.
.	.	.	.	.	.
124	x <sub>118</sub>	x <sub>118</sub>	x <sub>118</sub>	x <sub>118</sub>	yh <sub>120</sub>
125	x <sub>119</sub>	x <sub>119</sub>	x <sub>119</sub>	x <sub>119</sub>	yh <sub>121</sub>
126	x <sub>120</sub>	x <sub>120</sub>	x <sub>120</sub>	x <sub>120</sub>	yh <sub>120</sub>
127	x <sub>121</sub>	x <sub>121</sub>	x <sub>121</sub>	x <sub>121</sub>	x <sub>121</sub>

FIG. 7C



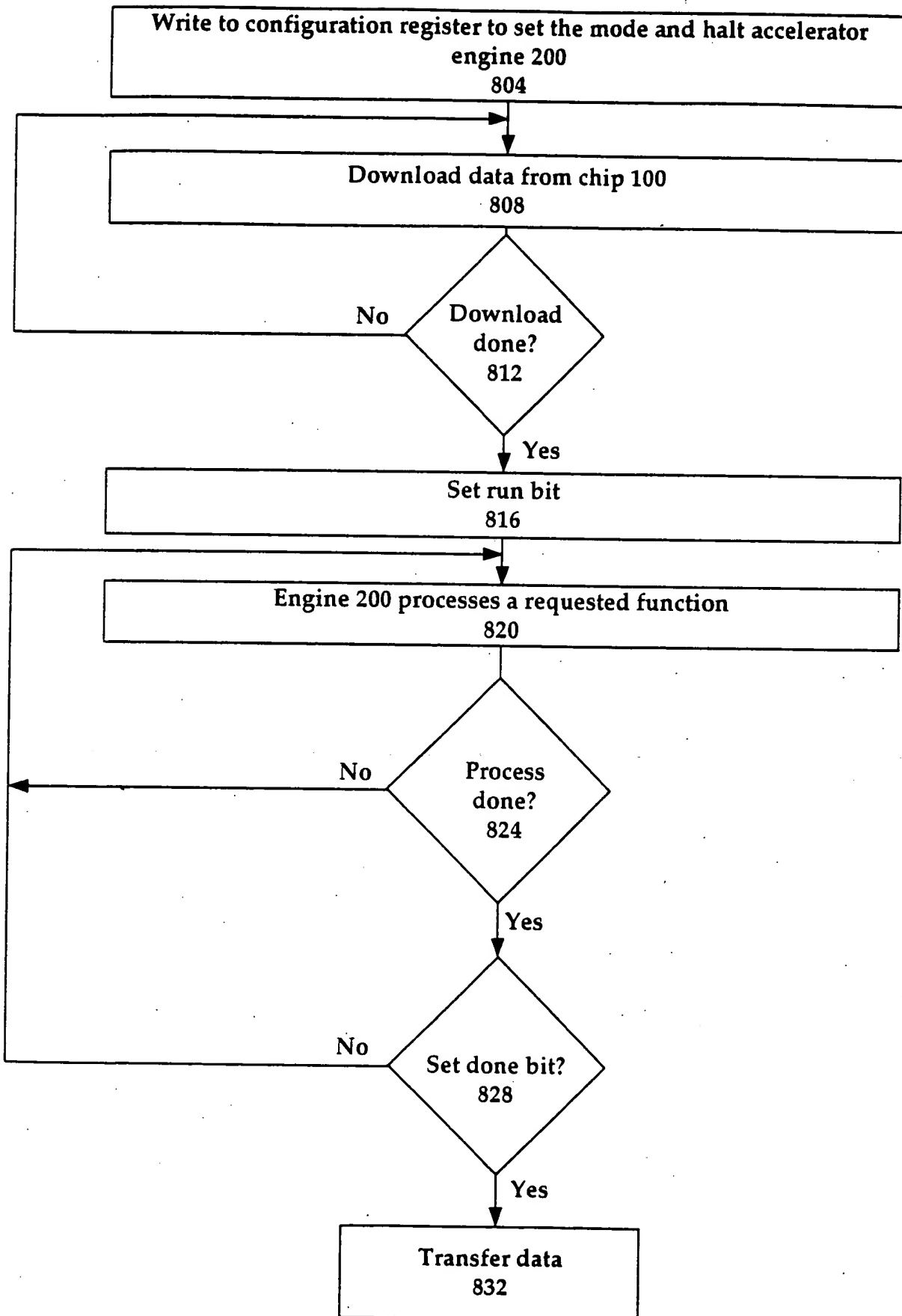


FIG. 8